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SURVEYS OF PUERTO RICAN SCREECH-OWL POPULATIONS IN LARGE-TRACT AND FRAGMENTED FOREST HABITATS

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ABSTRACT.—We conducted road surveys of Puerto Rican Screech-Owls (*Otus nudipes*) by playing conspecific vocalizations in secondary wet forest and fragmented secondary moist forest in rural areas of eastern Puerto Rico. Six paired surveys were conducted biweekly beginning in April. We recorded number of owl responses, cloud cover, wind speed, moon phase, and number of cars passing during 5-min stops at 60 locations. Owls responded in similar numbers ($P > 0.05$) in both habitat types. Also, we detected no correlation of the number of owls with cloud cover, wind speed, moon phase, or passing cars. *Received 29 Dec. 1995, accepted 15 May 1996.*

The endemic Puerto Rican Screech-Owl (*Otus nudipes*) is common throughout forested areas of mainland Puerto Rico but is thought to be extirpated on adjacent islands such as Culebra and Vieques (Raffaele 1989). Although Puerto Rican Screech-Owl populations may have declined in the early 1900s when many of the islands' forests were cleared (Wiley 1986a), Wiley (1986b) reports that the owl population recovered as forest cover increased and as trees grew large enough to provide suitable nesting and roosting cavities.

Unfortunately, Puerto Rican Screech-Owl populations have seldom been studied (Recher 1970, Snyder et al. 1987, Rivera-Milán 1995). Since Eastern Screech-Owl (*Otus asio*) abundance is positively correlated with amount of woodland habitat available (Nowicki 1974, Cink 1975, Smith et al. 1987), we hypothesized that Puerto Rican Screech-Owls occupy fragmented forests at lower densities, if at all. Our objective was to determine the relative abundance of owls in fragmented and large forests of eastern Puerto Rico.

METHODS

Study areas (each ~2500 ha) were in secondary subtropical wet forest (large tract) of the Luquillo Mountains at elevations from 90–455 m and in secondary subtropical moist forest

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(fragmented) near Naguabo, Puerto Rico (18°18′N, 65°30′W), at elevations from 22–224 m (Ewel and Whitmore 1973). The forests receive 233–392 cm of rainfall annually and have an average temperature of 25°C (Brown et al. 1983).

Percent cover of general habitat types was visually estimated by two observers to the nearest 10% within approximately 300 m of each owl survey point. Average percent cover in large-tract forest was 80% intermediate forest, 15% young forest, 4% scrub (storm blowdown areas), and 1% residential. Average percent cover at survey points in the fragmented forest was 27% intermediate forest, 9% young forest, 19% scrub, 34% pasture, and 11% residential.

To estimate relative owl populations, we conducted road surveys using vocalization playback to elicit owl responses. In each study area (12 km apart), we established three 3.6-km road surveys with 10 points per survey site (points 0.4 km apart). Distance between survey points was determined by research in the summer of 1990 and from home ranges determined for two radio-marked Puerto Rican Screech-Owls (Gannon et al. 1993). Roads with heavy traffic (>3 cars per 5-min point count) at night were avoided. Survey sites were selected by lottery from suitable roads (no heavy traffic) near Naguabo (Highway 971, 972, and 974) and in the Luquillo Mountains (Highway 988, 9966, and 191). Survey sites were paired between study areas, i.e., paired points were sampled simultaneously throughout the study.

We conducted six surveys during the owls' 1991 breeding season—five biweekly surveys beginning in late April and one in July. Surveys began 30 min after sunset (about 19:20) and ended about midnight. We randomly selected the survey order and rotated the order on subsequent samplings so that each point was sampled twice during early (19:20–21:00), mid- (21:00–22:30), and late evening (22:30–24:00).

At each point, we conducted a 5-min survey consisting of visual and aural observations. Playback overlapped the first 2 min of observation and was followed by 3 min of silence. The first minute of playback consisted of 30 sec of owl trills followed by 30 sec of "wild" trills or cackles (van der Weyden 1974). This sequence was repeated during the second minute after turning the speaker to the opposite direction and perpendicular to the edge of the road. We used Marantz® (model PMD 430) and Sony® (model TCM-5000EV) cassette recorders with amplified external speakers (Realistic® Minimus-0.6, 2 W) to broadcast owl calls. (Use of brand names does not constitute government endorsement.) Speaker volumes were equal and audible to us to 160 m. To test observer variability, two persons recorded owl responses independently and simultaneously at each point in the large-tract forest. Both observers were equally trained and experienced (Kepler and Scott 1981). At each point we recorded (1) number of initial owl responses within 5, 1-min periods, (2) cloud cover (nearest 10%), (3) wind speed (Beaufort scale), (4) moon phase, and (5) number of cars passing the point in 5 min.

We analyzed the data with t-tests (SAS Institute, Inc. 1988) that compared the mean differences ($\bar{d}$) of variables between paired points. Differences were considered significant at $P \leq 0.05$. Pearson correlation analysis (SAS Institute, Inc. 1988) was used to determine associations between number of owl responses with wind speed, moon phase, cloud cover, and number of cars. Weather conditions were different between the study areas during the surveys. More cloud cover ($\bar{d} = 17\%$, $P = 0.0001$) and higher winds (Beaufort scale, $\bar{d} = 1.7$, $P = 0.0001$) were present during surveys in large-tract forest. However, more cars ($\bar{d} = 0.8$, $P = 0.0001$) were present during surveys in fragmented forest. Because of these differences the association of weather and number of cars with number of owl responses was analyzed separately for each study area. Data were normalized using the square root of x (x = cloud cover and wind speed) and the square root of [y + 0.5] (y = number of owls, moon phase, and number of cars) transformations.

RESULTS

Paired mean difference ($\bar{d}$) of owl responses by study areas was not different from 0 (P = 0.53) among survey dates; therefore, data for all dates were pooled. No differences in owl responses were found between study areas (P = 0.31). In the large-tract forest, a total of 200 owl responses ($\bar{x}$ = 1.10 per point per survey) was found compared to 173 owl responses ($\bar{x}$ = 0.96 per point per survey) in fragmented forest (Table 1). Observers conducting simultaneous point surveys for owls in large tract forest did not detect owls in different numbers (overall $\bar{x}$ for observer 1 = 1.11 owls/point and $\bar{x}$ for observer 2 = 1.15 owls/point, P = 0.60). Cloud cover, wind speed, and number of cars were not associated with number of vocal responses of owls at either study area (r ranged from −0.054 to 0.12 and P from 0.12 to 0.97). In large-tract forest, the number of vocal responses of owls was weakly correlated with moon phase (r = 0.15, P = 0.04). No correlation was found between moon phase and number of vocal responses by owls in fragmented forest (r = 0.08, P = 0.22). Of a total of 373 aural and visual responses, 18.5% were recorded in the first minute, 4.8% in the second, 31.6% in the third, 22.0% in the fourth, and 23.1% in the fifth. Only, 4.8% of total contacts were visual, all occurring after the first survey minute.

DISCUSSION

Puerto Rican Screech-Owls responded similarly in fragmented habitat (36% forest cover) and large tract habitat (95% forest cover) which may indicate similar owl densities. This is contrary to studies on Eastern Screech-Owls in Michigan (Nowicki 1974) and Kansas (Cink 1975) which indicated that abundance was positively associated with forested habitat. Similar numbers of owls in fragmented and large-tract forests suggests that restoration of the Puerto Rican Screech-Owl may be possible in former ranges where forest habitat is fragmented (e.g., Vieques Island) but where nesting cavities (artificial or natural) and food resources are adequate.

Traditionally, the Vieques owl population has been listed as the *O. n. newtoni* subspecies (Bond 1956). However, lack of a specimen from Vieques and the paucity of information, in general, on the Puerto Rican Screech-Owl indicate that owls on this island were part of the geographically closer and more abundant race, *O. n. nudipes* (R. Banks, pers. commun.; J. Marshall, pers. commun.). In addition, there is some uncertainty as to the existence of two separate owl races (R. Banks, pers. commun.; Biaggi 1970). No attempts to introduce owls from Puerto Rico to the Virgin Islands should be undertaken while this species taxonomic status is in question.

TABLE 1

NUMBER OF PUERTO RICAN SCREECH-OWLS AND MEAN DIFFERENCE ($\bar{D}$) BETWEEN UNFRAGMENTED TROPICAL WET FOREST AND FRAGMENTED TROPICAL MOIST FOREST

	Total number of owls[a]		
	Unfragmented forest	Fragmented forest	$\bar{d}$
	7	3	0.67[b]
	5	3	0.33
	11	7	0.67
	6	7	−0.17
	9	7	0.50
	4	11	−1.17
	11	1	1.67
	5	4	−0.17
	9	4	0.83
	2	8	−1.00
	8	5	0.33
	11	7	0.67
	10	7	0.50
	6	5	0.17
	3	3	0.00
	10	2	1.33
	6	8	−0.33
	11	0	1.83
	4	3	0.17
	8	2	1.00
	5	4	0.17
	3	4	−0.17
	2	2	0.00
	10	17	−1.17
	5	9	−0.67
	5	3	0.33
	12	4	1.33
	1	8	−1.17
	10	11	−0.17
	1	14	−2.17
Total	200	173	

[a] Total number for six surveys of 5 min each.
[b] Mean difference per point per survey; paired t-test of mean difference (owls counted for point by survey for unfragmented forest minus owls counted for point by survey for fragmented forest) of transformed data is t = 1.31, df = 29, P = 0.20.

Future research, prior to screech-owl restoration efforts, should include surveys of former and current ranges to assess (1) the status of extant owl populations, (2) the availability of nesting and roosting cavities, and (3) the availability of food resources. Since these owls readily use nest boxes, otherwise suitable habitat can be supplemented with artificial cavities (Wiley 1985, 1986a). Our data further suggests that Puerto Rican Screech-Owls may be able to exist in moist and wet areas with fragmented forest cover of approximately 36%. But the extent to which Puerto Rican Screech-Owls use fragmented forest must also be determined. Is fragmented forest preferred owl habitat or does it serve only as a population sink for individuals dispersing from large-tract areas?

Smith et al. (1987) and Gerhardt (1991) reported that Eastern Screech-Owl and Mottled Owl (*Ciccaba virgata*) responses were negatively associated with wind speed, whereas Carpenter (1987) suggested that subzero temperatures had inhibitory effect on Eastern Screech-Owl calling. Unlike Eastern Screech-Owls (Smith et al. 1987, Ritchison et al. 1988, Carpenter 1987) and Mottled Owls (Gerhardt 1991), Puerto Rican Screech-Owl responses may be weakly associated with moonlight. This weak association was probably caused by the absence of full and new moon phases during our sampling periods. In Puerto Rico, the lack of association of owl responses to all weather conditions discussed above, except moonlight, may be related to the mild temperature fluctuations of the tropical environment.

Puerto Rican Screech-Owls responded well to conspecific vocalization playback, with contacts occurring throughout the 5-min period. However, the lower numbers of responses in the first 2 min suggests that playback may interfere with the observers aural detection ability. In addition, after a 5-min survey, the accumulated number of initial owl responses had not stabilized. Therefore, five minutes per point may not be long enough to provide data for quantitative estimates of the owl population. Some studies suggest at least a 10-min sample period when surveying Eastern Screech-Owls and other raptors, especially when trying to determine population densities (Mosher et al. 1990, De Geus and Bowles 1991).

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